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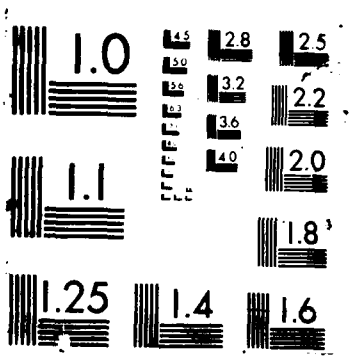
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A special vacuum system used to study the surface reactions in thin film deposition and etching was equipped with surface analytical techniques and ion sputtering for preparing and characterizing surfaces. X-ray and ultraviolet photoelectron spectroscopy systems were obtained from Vacuum Science Workshop and installed in a 2-chamber vacuum system along with an ion sputtering gun for sample cleaning. These techniques will be used in conjunction with infrared ellipsometry and modulated molecular beam techniques to elucidate the kinetics and mechanisms of surface reactions of silicon deposition and etching.



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SUBMITTED TO AFOSR-TR- 87-1588

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

# APPARATUS FOR THE STUDY OF SILICON FILM DEPOSITION AND SILICON ETCHING

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Time Period August 1,1986 - July 31,1987
AFOSR Grant No. AFOSR-86-0217

## INTRODUCTION

This grant funded the purchase of equipment for surface analytical techniques to be used in the study of surface reactions relevant to film deposition and etching reactions. The equipment is incorporated into a vacuum system funded in part by another AFOSR grant (AFOSR-86-0050), with additional funds from the state of New Jersey and institutional funds from Princeton University. This report will describe the equipment purchased and the overall system which the new equipment is a part of.

## RESULTS

Two research programs at Princeton University are currently sponsored by the AFOSR focusing on reactions at silicon surfaces. Professor Jay Benziger in Chemical Engineering is examining the kinetics and mechanisms of thin film deposition reactions. Infrared ellipsometry in conjunction with modulated molecular beams is being used to identify the stable surface species during deposition of silicon films. This work is being funded under AFOSR grant 86-0050. Professor Steven Bernasek is examining the kinetics of silicon etching using carbonyl fluoride, supported by AFOSR grant 85-0209. To facilitate work on these projects an ultrahigh vacuum chamber equipped with surface analytical techniques has been constructed. Funds from various sources have been used to equip this system, with a major fraction of the funding coming from the DOD URIP under AFOSR-86-0217.

The basic vacuum system for these studies is a two chamber system designed at Princeton and constructed by UHV Instruments. One chamber is equipped with a pulsed molecular beam source, quadrupole mass spectrometer, infrared transparent windows, and a heated sample manipulator. The molecular beam can be excited by an excimer laser to produce radical beams to simulate plasmas used in deposition and etching processes. The infrared windows are situated for use with our infrared ellipsometer. The second chamber is an analytical and preparative chamber used for cleaning and surface characterization. This chamber contains X-ray and ultraviolet photoelectron spectroscopy systems, quadrupole mass spectrometer, an ion sputtering source, and a sample manipulator with cooling and heating capabilities. A gate valve connects the two chambers and sample can be transferred between the two chambers under vacuum conditions.

During the time covered by this grant we have been primarily constructing this system. The funds provided by AFOSR-86-0217 were used to obtain the equipment listed below:

100 mm Electron Hemispherical Analyzer 0-5000ev
Twin anode X-ray source, Ti and Mg anodes
He discharge UV source
Computer Interface
Computer Software package for photoelectron spectroscopy system
Ion sputter gun and power supply

All this equipment and the computer software was obtained from Vacuum Science Workshop. This equipment has been installed and tested. A few minor items need to be modified of the photoelectron spectroscopy system

to improve the capabilities for ultraviolet photoelectron spectroscopy. We are working with Vacuum Science Workshop on these improvements and plan to have them completed by December 1987.

The overall experimental system is presently functional and we plan to have the first experimental data for publication available during the first part of 1988.

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